**Matsuura et al. is not Prior Art to the Present Invention**

The Matsuura et al. reference (U.S. Patent 6,372,080) was filed October 13, 1995 as Application No. 08/542,576, which was a continuation-in-part of Application No. 08/514,353 filed July 27, 1995 (now abandoned), which was a continuation of Application No. 08/218,544 filed March 28, 1994 (now abandoned). The Examiner indicated that the Matsuura et al. reference taught a heat-resistant adhesive having a water absorption rate of not more than 3 wt. % (col. 3, lines 12-18 and 37-56) and a method of manufacturing a semiconductor package (col. 12, line 1 to col. 13, line 40), (see Office Action dated June 6, 2001, page 3, lines 10-12). However, the subject matter that the Examiner relies upon was not present in Applications Nos. 08/218,544 and 08/514,353, but was added to Application No. 08/542,576. Any matter added to Application No. 08/542,576 that was not present in Applications Nos. 08/218,544 and 08/514,353 would not have an effective date earlier than the July 6, 1995 priority date of the present invention.

As proof of this fact, Applicants provide Exhibit A, attached herewith, that includes pages 5, 6, 24 and 25 from the file history of Application No. 08/514,353. It is clear that the subject matter of col. 3, lines 12-18, col. 12, lines 9-19, and col. 12, line 39 to col. 13, line 26, of the Matsuura et al. Patent was not present in Application No. 08/514,353. Therefore, this subject matter does not have an effective date that is earlier than the priority date of the present invention, and cannot be construed as valid prior art against the instant claims.

Specifically, col. 3, lines 12-18, define the term "water absorption rate." Without this definition, one skilled in the art could not have determined what was meant by water absorption

rate in the remainder of the specification. Therefore, the Matsuura et al. reference did not reasonably teach "an organic die-bonding film having a water absorption of 1.5% by volume or less" as recited in claims 17, 42 and 50 because the term "water absorption rate" was undefined and indeterminate to one of ordinary skill in the art in the original parent applications.

In addition, the manufacturing process for a semiconductor package disclosed in col. 12, line 39 to col. 13, line 40, of the Matsuura et al. Patent was not present in Application No. 08/514,353. Therefore, this subject matter does not have an effective date that is earlier than the priority date of the present invention, and cannot be construed as valid prior art against the instant method claims 42-45.

**Response to 37 C.F.R. §105 Requirement**

Applicants know of no conversion factor to convert the 90-degree peel strengths disclosed by the Morita et al. reference (U.S. Patent 5,406,124) to the 17-degree peel strengths used for testing purposes in the present invention (see Figure 2, and page 30, line 22 to page 31, line 8, of the instant specification). The issue is clouded further by the fact that the Morita et al. reference does not clearly describe how the 90-degree peel strength was measured. Assuming that Morita et al. measured 90-degree peel strength in the normal manner, the test would be measuring the adhesive force when the adhesive is peeled off the adherend in the vertical direction (normal to the surface of the adherend). The 90-degree peel strength is a measurement of the "linear adhesion strength" and is conventionally measured in units of

Kg/m.

On the other hand, 17 degree peel strength as measured in accordance with the method described in the present specification is a measurement of "areal adhesion strength" and is measured in units of Kgf/5mm x 5mm chip. Thus, there is no conversion factor for converting results of these two different tests that test different adhesive properties and report results in different non-convertible units.

The Masuko Declaration, filed on March 11, 2002, shows in Table 1 that under the die-bonding temperature and pressure conditions set forth in claim 43-45 adhesive films made in accordance with the teachings of the Morita et al. reference attain a 17-degree peel strength of 0.4 Kgf/5mm x 5 mm chip or less, whereas the adhesive films of the present invention attain 17-degree peel strengths of 0.55 Kgf/5mm x 5 mm chip or higher. This property is specifically claimed in claims 19, 20 and 23. Thus, it is shown that the stronger areal adhesive strengths of the organic die-bonding films of the present invention do not overlap with the weaker areal adhesive strengths of adhesives made in accordance with Morita et al. reference.

**The Invention**

Broadly, the present invention is directed to a material comprising an organic die-bonding film, wherein the material may be used in the field of semiconductor manufacturing. Specifically, in one preferred embodiment of the invention, the material comprises an organic die-bonding film having a water absorption of 1.5% by volume or less, and the material includes an epoxy resin

wherein the epoxy resin is any one of glycidyl ether, glycidylamine, glycidyl ester and an alicyclic epoxy resin. In other more limited embodiments, the material has a peel strength of 0.5 kgf/5 mm x 5 mm chip or higher when bonding a semiconductor to a support member.

In another preferred embodiment of the invention, a method of bonding a semiconductor chip to a support member, the method comprising the steps of: (a) providing a material comprising an organic die-bonding film having a water absorption of 1.5% by volume or less, and the material includes an epoxy resin wherein the epoxy resin is any one of glycidyl ether, glycidylamine, glycidyl ester and an alicyclic epoxy resin; and (b) bonding a semiconductor chip to a support member using the material.

In yet another preferred embodiment of the invention, a semiconductor device includes (a) a semiconductor chip; (b) a support member; and (c) a material comprising an organic die-bonding film having a water absorption of 1.5% by volume or less, and the material includes an epoxy resin wherein the epoxy resin is any one of glycidyl ether, glycidylamine, glycidyl ester and an alicyclic epoxy resin, wherein the material is provided between the semiconductor chip and the support member.

The main advantage of the material in accordance with the present invention is that, when manufacturing a semiconductor device and the like, there is a dramatic decrease in the number of defects in the material. Specifically, there are fewer reflow cracks (i.e., essentially none, as shown in Tables 1), which equates to a more durable and reliable semiconductor chip.

**The Rejection**

Claims 17, 19, 20, 23, 35, 40, 42-45 and 50 stand rejected under 35 U.S.C. 102(e) as anticipated by Matsuura et al. (U.S. Patent 6,372,080). Claims 17 and 40 stand rejected under 35 U.S.C. 102(e) as anticipated by, or in the alternative, under 35 U.S.C. 103(a) as unpatentable over, Takigawa (U.S. Patent 5,659,004). Claims 18, 21 and 22 stand rejected under 35 U.S.C. 103(a) as unpatentable over Takigawa. Claims 17, 19, 20, 23, 35, 40 and 42-45 stand rejected under 35 U.S.C. 103(a) as unpatentable over the combination of Morita et al. (U.S. Patent 5,406,124) and Takigawa. Claim 18 stands rejected under 35 U.S.C. 103(a) as unpatentable over the combination of Morita et al. and Takigawa, and further in combination with Hozoji (Japanese Document JP 52-18107).

Applicants respectfully traverse the grounds of rejection and request reconsideration for the following reasons.

**Applicants' Arguments**

As discussed above, the Matsuura et al. Patent cannot sustain a rejection under 35 U.S.C. §102(e) because the subject matter upon which the Examiner relies to anticipate the subject matter of claims 17, 42 and 50 is not valid prior art. Specifically, as discussed above, the definition of the term "water absorption rate" was added to the application for the Matsuura et al. Patent after the priority date of the present invention; therefore, the Matsuura et al. Patent could not teach what was a water absorption rate of 3 wt. % or less in any meaningful way. In addition, the description

of the process for manufacturing a semiconductor package was added to the application for the Matsuura et al. Patent after the priority date of the present invention, so the description of this process in the Matsuura et al. Patent is not valid prior art against claims 42-45.

In other words, the Matsuura et al. does not include a valid prior art teaching directed to "an organic die-bonding film having a water absorption of 1.5% by volume or less" as recited in claims 17, 42 and 50, and does not include a valid prior art description of "a method of bonding a semiconductor chip to a support member" as recited in claims 42-45.

The Takigawa reference discloses an "epoxy resin composition" that has an "absorbing ratio" that is measured in % and is related to the "absorption of boiling water" in accordance with the method disclosed in JIS K-6911 (see Abstract, col. 9, lines 60-63, and Table 1). However, the absorbing ratio is a different property from the "water absorption" disclosed on page 22, lines 5-9, of the present specification because water absorption is measured in vol. % and represents a ratio corrected for the density of the material. Furthermore, water absorption is a measurement of how much distilled water is absorbed at room temperature over 24 hrs, and is not a measurement of the absorption of boiling water (see present specification, page 21, line 23 to page 22, line 9). As Takigawa's absorbing ratio is a property that is a different and non-convertible property from the water absorption of the present invention, the Takigawa reference can not teach, or even suggest, "an organic die-bonding film having a water absorption of 1.5% by volume or less" as recited in claims 17, 42 and 50.

The Examiner argues that "Takigawa teaches that water absorption is a result-effective

variable" and cites In re Aller, 220 F.2d 454, 105 USPQ 233, 235 (CCPA 1969), (Office Action dated June 6, 2002). However, Takigawa does not teach that water absorption is a result-effective variable and In re Aller has been improperly applied.

First, Takigawa teaches that the "absorbing ratio" is a property of the resin, not a result-effective variable (col. 9, lines 60-63). Likewise, the water absorption of the organic die-bonding film in accordance with the present invention is a property of the film and is not a result-effective variable. In light of the deficiencies of Takigawa, the Examiner must produce a reference teaching that water absorption is a result effective variable.

Second, in In re Aller, a process for decomposing hydroperoxide that included bringing peroxides in contact with sulfuric acid at temperatures between 40-80°C was held to be unpatentable over a reference showing essentially the same process conducted at a temperature of 100°C. The court concluded that to find the optimum of conditions, such as temperature, required merely expected skill in the art and was unpatentable. Id. at 237. The present case is distinguished from In re Aller in that water absorption is a property of the film. It is a result. It is not a variable in a process that can be experimented with; thus, In re Aller does not apply.

Third, even if one were to improperly apply the rule provided by In re Aller, the teachings of the Takigawa reference fail to teach the same "result-effective variable." Specifically, if one were to assume that Takigawa's absorbing ratio was a result-effective variable ( an erroneous assumption given that the absorbing ratio is a property and not a variable), Takigawa teaches an absorbing ratio that is determined by exposure to boiling water and not to a water absorption

determined by exposure to water at room temperature. In In re Antoine, 195 USPQ 6, 8 (CCPA 1977), the court established that there were exceptions to In re Aller such as when the parameter to be optimized was not recognized to be a result-effective variable. In the present case, the Takigawa reference does not recognize water absorption as a result-effective variable because (a) the reference teaches an absorbing ratio that is distinctly different from the water absorption, and (b) both the absorbing ratio and the water absorption are properties of a material and not variables in a process.

The Morita et al. reference discloses an "insulating adhesive tape" that includes a base supporting film and an adhesive layer formed on at least one surface thereof (see Abstract). The adhesive layer is a thermoplastic polymer comprising a thermoplastic polyimide, wherein the polymer has a glass transition temperature ranging from 180°C to 280°C and an elastic modulus ranging from $10^{10}$ dyne/cm$^2$ to $10^{11}$ dyne/cm$^2$ at 25°C, wherein the elastic modulus includes a value ranging from $10^2$ dyne/cm$^2$ to $10^9$ dyne/cm$^2$ at a temperature between 250°C and 300°C. Morita et al. discloses that the thermoplastic polymer has a water absorbing ratio of less than 1.2% (col. 9, lines 14-16); however, Morita et al. does not explicitly state to what the percentage is relative. Specifically, Morita et al. only describes **% by weight** (col. 9, lines 35-39 and lines 53-55); therefore, it is suggested that Morita et al. describes that the water absorbing ratio is less than 1.2% by weight. **There is nothing in the Morita et al. reference to teach, or even suggest, that the water absorption of 1.5% by volume or less** as required by claims 17, 42 and 50.

Furthermore, Applicants point out that the Examiner admits that Morita et al. does not

disclose a "17 degree peel strength of 0.5 Kgf/5mm x 5mm chip or above" (Office Action, dated September 10, 2001, page 9, lines 11-15), but the Examiner asserts that in the absence of unexpected results that such an increase in peel strength would be "ascertainable by routine experimentation and optimization" (Office Action, dated September 10, 2001, page 9, line 16 to page 10, line 5).

Applicants submitted for the Examiner a Declaration by Takashi Masuko (hereafter the "Masuko Declaration"), dated March 5, 2002 and filed in accordance with 37 C.F.R. 1.132 on March 11, 2002. The Matsuko Declaration establishes that when the novel film (see Section 7 on page 3) in accordance with the present invention is compared to the prior art film (see Section 6 on page 3) disclosed by Morita et al. under identical experimental conditions, the result is that the novel film of the present invention demonstrates an "unexpected invulnerability" (page 7, lines 4-8). As shown in Table 2, when evaluating the two films for the occurrence of reflow cracks it was shown that while **all** of the Morita film samples under the given die-bonding conditions manifested reflow cracks, **none** of the samples made in accordance with the present invention had reflow cracks. In addition, when peel strength was measured (Matsuko Declaration, section 8) the peel strength was significantly greater for the novel film of the present invention over the Morita film (see Table 1). In fact, when the die-bonding condition was set as "250°C x 30gf/mm$^2$ x 20 sec," all of the chips made using the novel film were destroyed during testing because the bond strength was stronger than the chip. In other words, the bond strength of the material in accordance with the present invention was stronger than what this particular test could measure!

Clearly, this is another superior and unexpected result.

When comparing the experimental results of the Rule 132 declaration to the instant claims, it is clear that the present invention as claimed in the broadest claims is superior in an unexpected way to the invention disclosed by Morita et al. Specifically, as shown in Table 1 of the Matsuko Declaration, the invention disclosed by Morita et al. is not capable of achieving the "peel strength of 0.5 kgf/5 mm x 5 mm chip or higher," being the 17 degree peel strength (an areal adhesion strength) defined on page 33, lines 1-16 and Figure 2 of the present application, as recited in claims 19, 20 and 23. Furthermore, from Table 1 of the Matsuko Declaration it can be seen that the film disclosed by Morita et al. is not capable of adhesively binding given the conditions of method claim 45.

In addition, Morita et al. does not teach the particular epoxy resin recited in claim 17, or that the component includes polyimide in addition to the epoxy resin as recited in claim 35 as admitted by the Examiner (Office Action dated June 6, 2002, page 12, lines 17-19).

Thus, the Morita et al. reference can not anticipate, or render obvious, the subject matter of base claims 17, 42 and 50, because Morita et al. does not teach, or even suggest, that **the water absorption is 1.5% by volume or less**, or the particular epoxy resin. In addition, the Matsuko Declaration clearly shows that the film disclosed by Morita et al. does not adhesively bind under the conditions recited in claim 45, and the film disclosed by Morita et al. does not have a 17 degree peel strength of "0.5 Kgf/5mm x 5mm chip or above" as recited in claims 19, 20 and 23. As discussed above, it would be clear that any combination of the Morita et al. reference with the

Takigawa reference cannot teach that **the water absorption is 1.5% by volume or less** as recited in claims 17, 42 and 50. Furthermore, the Takigawa reference cannot make up the deficiency of the Morita et al. reference with respect to the recitation of peel strengths and bonding conditions in claims 19, 20, 23 and 45.

However, even if a *prima* facie case of obviousness can be inferred from the combined teachings of Morita and Takigawa (which is not a reasonable inference), it is plainly shown that the present invention provides superior and unexpected improvements in both peel strength and reflow crack development over the Morita et al. adhesive tape. Specifically, the peel strength of the novel film in accordance with the present invention is consistently and significantly stronger than the peel strength of the Morita et al. film, and in some cases the peel strength of the instant novel film was so strong that it could not be fully measured using the present techniques. In addition, the novel film in accordance with the present invention was "unexpectedly invulnerable" to the formation of reflow cracks, whereas 100% of the Morita films developed reflow cracks.

Hozoji discloses a "resin-sealed semiconductor device" wherein a die pad and a semiconductor element are fixed by using an adhesive layer in which a base material having a low moisture absorption rate (i.e. glass cloth or metal foil) is impregnated or coated with a bisphenol type epoxy resin, wire bonded, and with resin containing one or more of epoxy, phenol or polyimide resins (see Abstract). In addition, Hozoji teaches several desired low water absorption rates being changes in weight over a period of time (see paragraph [0016] and Table 1). Hozoji does not teach that **the water absorption is 1.5% by volume or less** as recited in claims 17, 42

and 50.

Finally, Applicants make the following general remarks. The Examiner cites numerous cases in a manner so general that it is unclear how the Examiner is using these cases to support a rejection. As discussed above, Applicants have shown that the Examiner has improperly applied In re Aller and Applicants assert that it would be an undue burden on the Applicants to address all of the cited case law when the Examiner has made no attempt to show how the cited case law applies to the facts of the present case. Applicants also point out that the Examiner has erroneously treated the "saturation moisture absorption" recited in claim 18, the "modulus of elasticity" recited in claims 21 and 22, and the "peel strength" recited in claims 19, 20 and 23 as "result-effective variables," (Office Action dated June 6, 2002, page 10, lines 1-12, and page 13, lines 18-20), when in fact these features are properties of the claimed material and are not result-effective variables attributable to a process. Therefore, the Examiner's argument that it would be obvious to manipulate these "variables" is unsound. Likewise, the Examiner's unsubstantiated opinion that "it would have been an obvious matter of design choice" (Office Action dated June 6, 2002, page 10, lines 3-12, and page 13, lines 20-23) to invent a material having the claimed properties of claims 18, 21 and 22 is without merit and should be withdrawn.

**Conclusion**

Applicants have established, by filing a certified English translation of the Japanese priority document and by providing Exhibit A, that the Matsuura et al. Patent can not be used as

valid prior art for the purposes of making a rejection under 35 U.S.C. 102(e) against the instant claims. Furthermore, Applicants have shown that the Takigawa reference, the Morita et al. reference and the Hozoji reference, either alone or in combination, fail to disclose that the material would have a **water absorption that is 1.5% by volume or less**; therefore, the Examiner's proposed rejection of claims 17-23, 35, 40, 42-45, and 50 is untenable and should be withdrawn. Lastly, even if a *prima facie* case of obviousness could be established (which it cannot), the Matsuko Declaration clearly establishes that the instant invention provides both superior and unexpected bonding peel strength and an unexpected invulnerability to the formation of reflow cracks.

For these and all of the above reasons, claims 17-23, 35, 40, 42-45 and 50 are in condition for allowance and a prompt Notice of Allowance is earnestly solicited.

Questions are welcomed by the below signed attorney for the Applicants.

Respectfully submitted,

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